Quasi-Observation approach for the combination of space and terrestrial geodetic data

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Abstract:

Quasi-observations provide an efficient mechanism for combining different types of geodetic data to estimate tectonically induced secular motion and episodic site motion in a region of active deformation. The primary observations are analyzed separately to produce loosely constrained estimates of station positions and network parameters. Then these loosely constrained estimates are combined as quasi-observations to estimate a velocity field and coseismic and/or postseismic displacements. This approach has three obvious advantages: (1) the reference frame is defined at the final stage so that a variety of constraints may be tested and applied uniformly to the solution; (2) computation time and file storage are substantially reduced; (3) there is more flexibility to use stachastic perturbations to represent time-dependent errors and excitation processes.

The use of quasi-observations also introduces challenges to the analysis, including the appropriate definition of chi-square for Kalman filtering, criteria for testing compatibility among different types or different segments of data, the notion of non-integer degrees of freedom to describe the impact of finite constraints and stochastic perturbations, and the formulation of internal constraints. We discuss our approach to each of these issues, balancing theoretical and practical considerations. We use as examples the horizontal velocity field from the combination of terrestrial trilateration and survey-mode GPS observations in southern California, estimation of postseismic deformation following the 1992 Landers (California) earthquake, and the filtering of seasonal signals in continuous GPS observations at IGS stations.